NASA TECH BRIEF

Simple Bonding Technique for High-Temperature Ceramic Coatings

Phosphate-bonded ceramic coatings such as zirconia (ZrO_2) have been used for many high-temperature applications. Such coatings, depending on formulation and environmental conditions, are refractory and reasonably chemically stable, and resist erosion. Phosphate-bonded zirconia is now made by mixing of zirconia powder, monofluorophosphoric acid, and ammonium dihydrogen phosphate. These coatings, however, have proved to be unreliable at high temperatures because of excessive spalling or flaking.

A recent investigation has found that the fluorine ion need only be present in very small concentrations for zirconia coatings to perform well at elevated temperatures. Thus the coating system can be simplified to zirconia powder bonded with orthophosphoric acid plus a small amount of hydrofluoric acid.

Although a 20:1 ratio (by weight) of orthophosphoric acid to hydrofluoric acid produces a useful mixture with good working and bonding properties, this ratio is not restrictive. Formulation of the coating depends also on the method of application: pour coating, dip coating, trowelling, or spray coating.

After the aqueous slurry coating is applied to the metallic surface by one such method, only a 600°F cure is required before service. These simplified phosphate-bonded zirconia coatings are hard, strong, and refractory, resist thermal shock, and provide very good thermal protection.

This coating system has survived multiple thermal shocks, between 70°F and temperatures above 4000°F, while protecting water-cooled metal substrates in tests with arc-plasma jets. Currently the coating system is performing well under exposure to combustion gases (temperature, about 5000°F) in tests with rocket motors; it does not appreciably erode, spall, or undergo detrimental chemical reactions.

This simplified bonding technique resulted from a continuing investigation of protective coating systems for regeneratively cooled rocket engines. Formulation studies of phosphate-bonded thoria (ThO_2) coatings have produced strong, shock-resistant coatings; the thoria studies, however, are much less advanced than the zirconia developments. This bonding technique, which provides an insulating refractory coating that is easy to repair, should find many industrial uses where the substrate material is well cooled and the coating's surface operates at temperatures up to 5000°F. A potential use may be in induction furnaces.

Notes:

1. The following documentation is available from:
   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-CR-72569 (N69-35125), Protective Coating System for a Regeneratively Cooled Thrust Chamber - Tasks I & II
2. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10580

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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